Cleanliness requiments on rubber products

13 July 2018

What does the customer ask for?
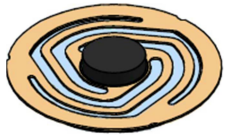
-LA PARTE DEVE ESSERE ESENTE DA BAVE, SPIGOLI VIVI, OLII E SOSTANZE SUPERFICIALI
CONTAMINANTI CHE POTREBBERO ESSERE NOCIVI PER UN SODDISFACENTE ASSEMBLAGGIO, UNA
SICURA MOVIMENTAZIONE, O IL FUNZIONAMENTO DELLA PARTE.
-PART MUST BE FREE FROM BURRS, SHARP EDGES, OILS AND SURFACE CONTAMINATES, WHICH
MIGHT BE DETRIMENTAL TO SATISFACTORY ASSEMBLY, SAFE HANDLING OR FUNCTION OF PART.

-PULIZIA E CONDIZIONI DI FORNITURA:
GRANULOMETRIA:
- N° di particelle di dimensioni superiori a 400 µm < 130/1000 cm²
- N° di particelle di dimensioni superiori a 150 µm < 2000/1000 cm²
- N° di particelle di dimensioni superiori a 15 µm < 250000/1000 cm²
- Non è ammessa alcuna particella di dimensioni superiori a 1000 µm.
GRAVIMETRIA: LIVELLO <25 mg/1000 cm²
SUPERFICIE DEL PEZZO: 3.63 cm²
MASSA PARTICELLE: 0.1 mg max

-CLEANLINESS REQUIREMENTS:
GRANULOMETRY:
- Nr. of particle...
- Nr. of particle...

Distribution of dimensions

N.B. evitare la presenza di impront...
nella zona destinata al costampaggio.

Dimensione massima impurità ammesse sul
componente < 300micron

Max allowed dimension

MAGNETI MARELLI

FREE CHOICE BLOCK CONTAMINATION

Magneti Marelli Powertrain S.p.A.
Laboratorio Materiali

Page 22 / 27

Clutch hydraulic circuit components filled with oil DOT by Customer must respect the Customer cleanliness
specification limits and indicated on the Marelli drawing.

The **components of the low pressure circuit** must respect the following limits of the residual contaminant weight:

Wet surface [cm²]		
≤ 25	≤ 0,0100	
26 ÷ 50	≤ 0,0075	
51 ÷ 100	≤ 0,0045	per wet surface [mg/cm²]
101 ÷ 250	≤ 0,0030	
251 ÷ 400	≤ 0,0015	
401 ÷ 600	≤ 0,50	
601 ÷ 750	≤ 0,75	per component [mg/pz]
751 ÷ 1000	≤ 1	
> 1000	≤ 2	

NOTE: The above mentioned limits include all measurement and sample preparation errors and refer to components
that have been washed using laboratory equipment. The presence of metallic particles, fragments of polymeric
materials, woven fibres, and pieces of tissue or paint with dimensions exceeding 1500 µm are not acceptable.

The **high pressure hydraulic pipes/hoses** must have a contamination cl... 8B/8C/8D/8E/4F$_1$/4F$_2$/5F$_3$, referring to
a sample of 2 parts washed by flushing. All the contaminant must have ... con oxide (SiO$_2$) content ≤ 20%, with

Max contamination weight /surface + Max allowed dimension

NOTA :
Nettoyage et dégraissage suivant la norme ISO 15001 :
Contamination aux hydrocarbures < 220 mg/m²
Absence de particules > 100 µm
Cotation fonctionnelle disponible dans le dossier ...

MATIERE : CW614N et PU vulcanisé	REF. MATIER...		
PROTECTION : Sans	RUGOSITE :	VOLUME : cm3	MASSE :
TOLERANCE GENERALE ISO 2768-mK	TOLERANCEMENT ISO 8015	TOLERANCE FILETAGE 6H/6g	
AIR LIQUIDE Healthcare	ECHELLE : 1:1	...RMAT : A3	PAGE :
	ENSEMBLE :		

**Max allowed dimensions +
max organic contamination weight/part
(medical gas applications)**

Is this possible no matter the process? It is just a matter of cleaning?

Case 1: sandblasted metal part; cleaned with compressed air (no clean room)
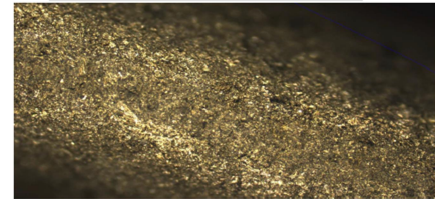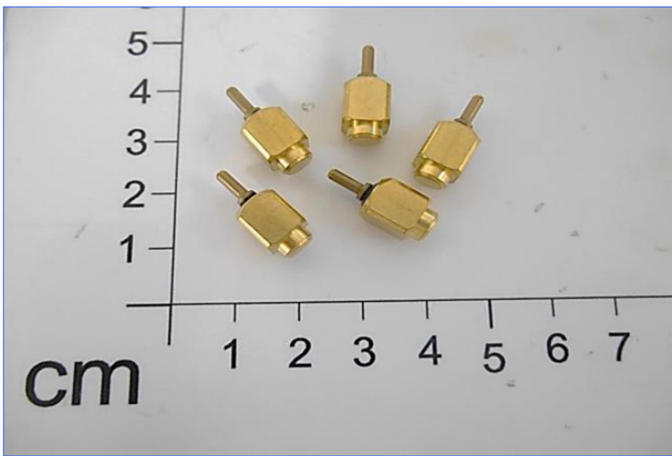
TABLE DE COMPTAGE

ISO 16232		
Classe	Nombre de particules	Comptage normalisé (1)
5 - 15 µm (B)	226964	3242,3
15 - 25 µm (C)	64217	917,4
25 - 50 µm (D)	31117	444,5
50 - 100 µm (E)	5181	74,0
100 - 150 µm (F)	406	5,8
150 - 200 µm (G)	82	1,2
200 - 400 µm (H)	50	0,7
400 - 600 µm (I)	1	0,0
600 - 1000 µm (J)	3	0,0
>= 1000 µm (K)	1	0,0
Total	328022	4686,0
dont Fibres (2)	111	1,6
dont brillante (3)	39953	570,8

CCC : N(B3242/C917/D445/E74/F6/G1/H1/I0/J0/K0)

(1) 70 pièces rapportées à 1 pièce.
(2) Fibres : médiane > 100 µm et allongement (M/e) > 10,0.
(3) brillante : éclat > 5,00 %.
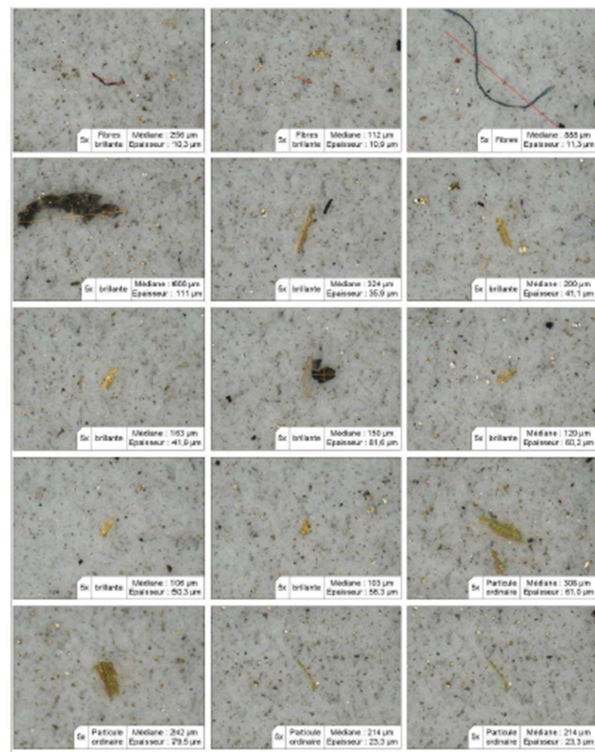
Statistiques

	Toutes les particules	Particules ordinaires	Fibres	brillante
Nombre	379186	339185	111	39957
Moyenne	13,0 µm	11,0 µm	183 µm	29,7 µm
Ecart type	11,8 µm	7,73 µm	138 µm	21,5 µm
Minimum	1,68 µm	1,68 µm	100 µm	3,82 µm
Maximum	1200 µm	308 µm	1200 µm	1200 µm
Moyenne quadratique	17,6 µm	13,5 µm	229 µm	36,7 µm

➢ A lot of brass chips and rubber debris most of them with dimension < 0,4 mm
➢ fibers up to 1,2 mm

☞ What happens if we clean the parts with water +ultrasound ?

Case 2: sandblasted metal part; cleaned with water + ultrasound (no clean room)

Test object

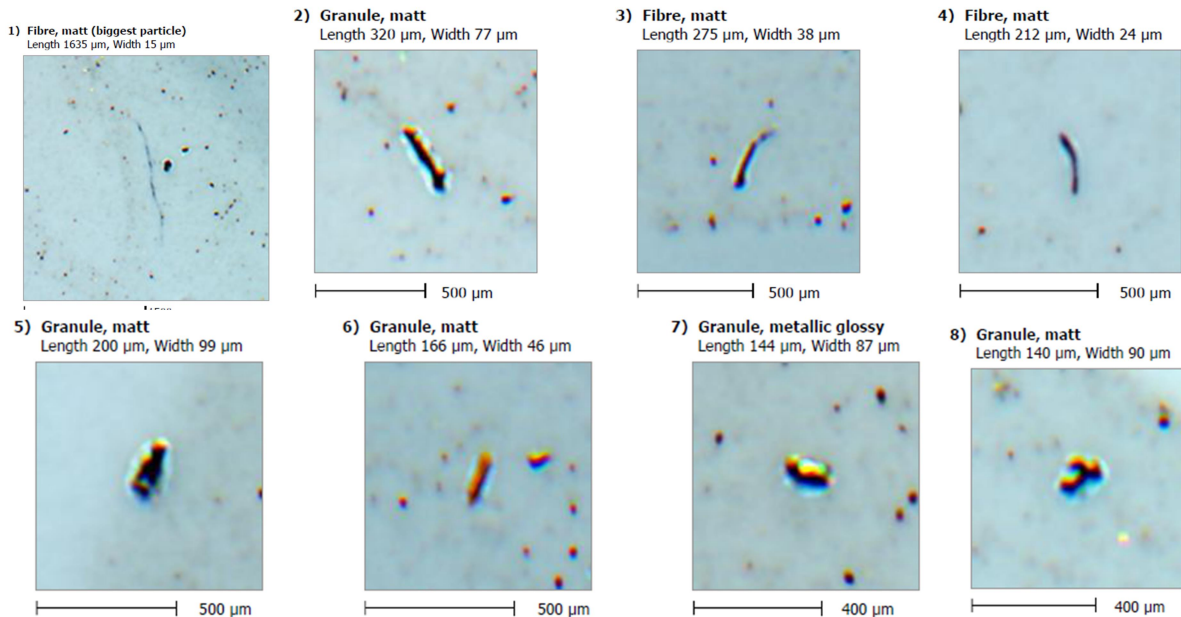|	
Identification	Metal Part
Part number	P 1509500
Batch number	clean #2
Sampling	shipping department, 19.04.2017 Entrance at RJL
Delivery	transparent bag, closed
Area extracted	complete
Number of Samples	10
Surface area	43.2 cm²
Volume	-
Test directive	ISO 1501, see attached page 6

Length-number histogram

Frequency scaled, not cumulated

Number per length class (µm)	Total Σ	[15; 25)	[25; 50)	[50; 100)	[100; 150)	[150; 200)	[200; 400)	[400; 600)	[600; 1000)	[1000; 1500)	[1500; 2000)	[2000; 3000)	[3000; ...)
Granules matt*	117388	81551	28936	6112	718	24	47	0	0	0	0	0	0
Granules metallic glossy*	1900	672	880	209	139	0	0	0	0	0	0	0	0
Fibres matt*	71	0	0	0	0	0	47	0	0	0	24	0	0
Fibres glossy*	0	0	0	0	0	0	0	0	0	0	0	0	0
Particles in selected classes*	119359	82223	29816	6321	857	24	94	0	0	0	24	0	0
tolerable particles	-	-	-	-	0	0	0	0	0	0	0	0	0

Component cleanliness code* (CCC) A (C17/D15/E13/F10/G5/H7/I00/J00/K00/L5/M00/N00)

Sedimentation number*   662297 / (1 h x 1000 cm²)

1) Fibre, matt (biggest particle)
Length 1635 µm, Width 15 µm

2) Granule, matt
Length 320 µm, Width 77 µm

500 µm

3) Fibre, matt
Length 275 µm, Width 38 µm

500 µm

4) Fibre, matt
Length 212 µm, Width 24 µm

500 µm

5) Granule, matt
Length 200 µm, Width 99 µm

500 µm

6) Granule, matt
Length 166 µm, Width 46 µm

500 µm

7) Granule, metallic glossy
Length 144 µm, Width 87 µm

400 µm

8) Granule, matt
Length 140 µm, Width 90 µm

400 µm

➢ Brass chips and rubber debris with dimension < 0,4 mm
➢ Fibers up to 2 mm
⇨ Small (27% in this case) improvement in particles number but same maximum dimensions

☞ Is this result reliable ?

Case 3: sandblasted metal part; cleaned with water + ultrasound (no clean room)

Prüfobjekt / Sample

Bezeichnung / Identification : Metal Sample
Prüfvorschrift / Test Directive : VDA-19:2015-03/ISO-16232:2007-06
Probeneingang / Entry date : 10.11.2015
Transport / Transportation : per Paketdienst / by parcel service
Verpackung / Packaging : ordnungsgemäß / proper

Extraktion / Extraction

Verfahren / Technique : Spritzen mit Drucksprüher, Mitteldruck
Rinsing with pressure sprayer, medium pressure
Weitere / Further details : siehe Anhang A / see Appendix A

DMAX (µm) Klasse/class	Total Particles	Maximum	[50.0- 100.0)	[100.0- 150.0)	[150.0- 200.0)	[200.0- 400.0)	[400.0- 600.0)	[600.0- 1000.0)	>>>
Ferrous Particles	26	153.3	22		4				
Ferrous Chips	31	173.1	17	9	4				
Non-Ferr. Particles	1946	499.2	1549	327	39	26	4		
Non-Ferrous Chips	3730	252.7	3254	384	79	13			
Mineral Particles	11508	354.5	10072	1130	209	96			
Mineral Fibres	1850	193.1	1754	83	13				
Other Particles	105	169.4	100		4				
Particles of interest	19194	499.2	16768	1933	353	135	4		

Statistics Total, Maximum, >>>
Parameter DMAX
Method Reclassified with ZLM_Standard_2015.zrr
Normalize Normalized to 1056 mm² of search area

➢ Brass chips and rubber debris with dimension < 0,6 mm
⇨ 0,6 mm should be considered as max dimension of particle NOT including environmental contamination

☞ What happens if we clean the parts with water in clean room ?

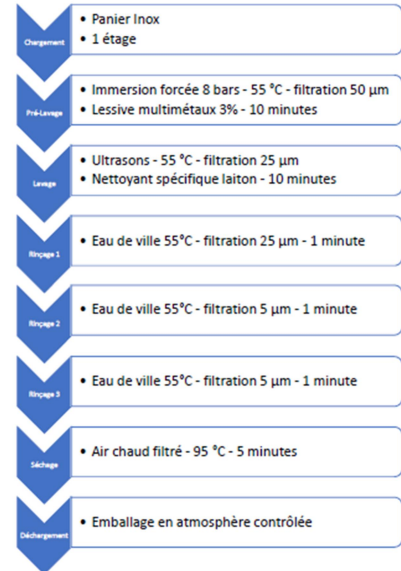**Case 4: sandblasted part, cleaned with 8 bar water + ultrasound in clean room**

- Chargement
  - Panier Inox
  - 1 étage
- Pré-Lavage
  - Immersion forcée 8 bars - 55 °C - filtration 50 µm
  - Lessive multimétaux 3% - 10 minutes
- Lavage
  - Ultrasons - 55 °C - filtration 25 µm
  - Nettoyant spécifique laiton - 10 minutes
- Rinçage 1
  - Eau de ville 55°C - filtration 25 µm - 1 minute
- Rinçage 2
  - Eau de ville 55°C - filtration 5 µm - 1 minute
- Rinçage 3
  - Eau de ville 55°C - filtration 5 µm - 1 minute
- Séchage
  - Air chaud filtré - 95 °C - 5 minutes
- Déchargement
  - Emballage en atmosphère contrôlée

TABLE DE COMPTAGE

ISO 16232		
Classe	Nombre de particules	Comptage normalisé (1)
5 - 15 µm (B)	1250	17,9
15 - 25 µm (C)	198	2,8
25 - 50 µm (D)	135	1,9
50 - 100 µm (E)	34	0,5
100 - 150 µm (F)	0	0,0
150 - 200 µm (G)	0	0,0
200 - 400 µm (H)	0	0,0
400 - 600 µm (I)	0	0,0
600 - 1000 µm (J)	0	0,0
>= 1000 µm (K)	0	0,0
Total	1617	23,1
dont Fibres (2)	0	0,0
dont brillante (3)	72	1,0

CCC : N(B18/C3/D2/E0/F0/G0/H0/I0/J0/K0)

(1) 70 pièces rapportées à 1 pièce.
(2) Fibres : médiane > 100 µm et allongement (M/e) > 10,0.
(3) brillante : éclat > 5,00 %.

Statistiques

	Toutes les particules	Particules ordinaires	Fibres	brillante
Nombre	2140	2068	0	72
Moyenne	10,7 µm	9,74 µm		39,4 µm
Ecart type	10,7 µm	8,61 µm		20,5 µm
Minimum	3,49 µm	3,49 µm		5,21 µm
Maximum	96,5 µm	92,3 µm		96,5 µm
Moyenne quadratique	15,2 µm	13,0 µm		44,5 µm

- ➢ Limited number of brass chips , rubber debris and fibers with dimension < 0,1 mm
- ⇨ Cleaning with high pressure water in clean room seem to be the solution …

- ☝ .. but what happens if we shakes these very clean parts ?

**Case 5: sandblasted part, cleaned with water + ultrasound in clean room; shaked**

TABLE DE COMPTAGE

ISO 16232		
Classe	Nombre de particules	Comptage normalisé (1)
5 - 15 µm (B)	3553	50,8
15 - 25 µm (C)	1264	18,1
25 - 50 µm (D)	987	14,1
50 - 100 µm (E)	392	5,6
100 - 150 µm (F)	66	0,9
150 - 200 µm (G)	26	0,4
200 - 400 µm (H)	24	0,3
400 - 600 µm (I)	3	0,0
600 - 1000 µm (J)	1	0,0
>= 1000 µm (K)	3	0,0
Total	6319	90,3
dont Fibres (2)	12	0,2
dont brillante (3)	652	9,3

CCC : N(B51/C18/D14/E6/F1/G0/H0/I0/J0/K0)

(1) 70 pièces rapportées à 1 pièce.
(2) Fibres : médiane > 100 µm et allongement (M/e) > 10,0.
(3) brillante : éclat > 5,00 %.
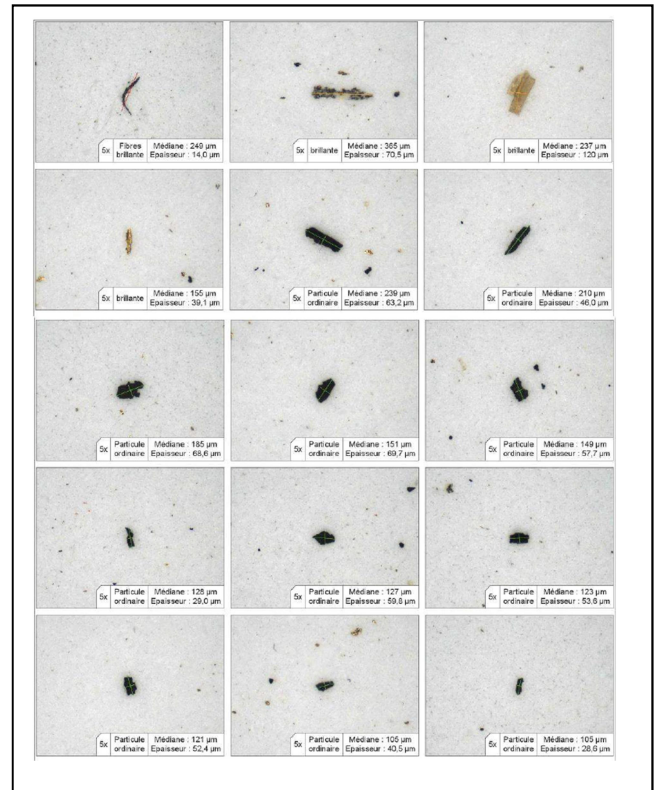
Statistiques

	Toutes les particules	Particules ordinaires	Fibres	brillante
Nombre	6917	6243	12	666
Moyenne	21,1 µm	16,0 µm	698 µm	59,6 µm
Ecart type	49,3 µm	15,9 µm	762 µm	70,1 µm
Minimum	3,36 µm	3,36 µm	139 µm	3,82 µm
Maximum	2970 µm	241 µm	2970 µm	1180 µm
Moyenne quadratique	53,6 µm	22,6 µm	1030 µm	92,1 µm

> ➢ Increase (+327%) of brass chips and rubber debris even if total amount is still very small (2,5% of case 2), most of them with dimension < 0,4 mm
> ➢ few particles up to 3 mm (Note that parts had been cleaned in clean room)
> ⇨ Conclusion: sandblasting cannot be used for rubber to metal parts with tight cleanliness requirement.

> ☝ what if we replace metal with plastic?

Case 6: sandblasted plastic part; cleaned with water + ultrasound (no clean room)

Prüfobjekt / Sample

Bezeichnung / Identification : Sealing Set Mahindra VOP B100 - PN: S565.13.MD, Date: 09/04/2015
Prüfvorschrift / Test Directive : VDA-19:2004-09/ISO-16232:2007-06
Probeneingang / Entry date : 20.04.2015
Transport / Transportation : per Paketdienst / by parcel service
Verpackung / Packaging : ordnungsgemäß / proper

Extraktion / Extraction

Verfahren / Technique : Spritzen mit Drucksprüher, Mitteldruck
Rinsing with pressure sprayer, medium pressure
Weitere / Further details : siehe Anhang A / see Appendix A

DMAX (µm) Klasse/class	Total Particles	Maximum	[5.0-15.0)	[15.0-25.0)	[25.0-50.0)	[50.0-100.0)	[100.0-150.0)	[150.0-200.0)	[200.0-400.0)	[400.0-600.0)	[600.0-700.0)	[700.0-1000.0)	>>>
Fibre	235379	125.5	211785	19895	2908	758	33						
Chip	139580	214.9	119233	16341	3508	465	8	16	8				
Particle	552950	243.5	475085	60747	13710	3017	302	65	25				
Particles of interest	927909	243.5	806103	96983	20126	4240	342	82	33				

Statistics Total, Maximum, >>>
Parameter DMAX
Method Reclassified with ZL_Standard_2015.zrr
Normalize Normalized to 9132 mm² of search area

Bewertung / Evaluation

Requirements fullfilled!

	Requirement	Reached value	Evaluation
Gravimetry	< 0.07 mg / part	0.0066 mg / part	**fullfilled**
Particle size	no particles > 700 µm	0 particles > 700 µm	**fullfilled**

Restschmutzgewicht / Particle Mass

2.69 mg pro 1000 cm² Oberfläche / per 1000 cm² surface area

➢ Fibers and rubber debris most of them with dimension < 0,4 mm
⇨ Rubber debris distribution is similar to the previous cases

☞ Is this result reliable ?

Case 7: sandblasted plastic part; cleaned with water + ultrasound (no clean room)

Test object

|	
Sample name	**Guarnizione de tenuta**
Sample number	**P/N: 097003**
Project	**our Ref.-No.: 25214A/13**
Test directive	VDA-19:2004-09/ISO-16232:2007-06
Level required	Gravimetry < 25 mg, max. amout of particles per class see histogram-table
Sample entry	11.06.2013, delivery per parcel service, transparent bag, closed

Length-number histogram   (Frequency scaled, not cumulated)

| Number per length class (µm)	Particles total	Granules matt	Granules glossy	Fibres matt	Fibres glossy	Sum of selected particle fractions: Matt fibres excluded	max. number
[15; 150)	97358	97213	67	78	0	97280	250000
[150; 400)	377	265	12	100	0	277	2000
[400; 1000)	101	23	0	78	0	23	130
[1000; ...)	78	0	0	78	0	0	0
Total	97914	97501	79	334	0	97580	

#1 Granule, matt
Length 534 µm, Width 254 µm
800 µm
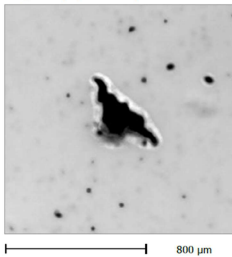
#2 Granule, matt
Length 454 µm, Width 326 µm
800 µm
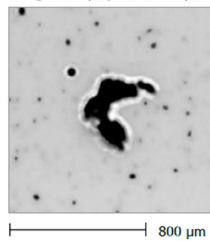
#3 Granule, matt
Length 359 µm, Width 230 µm
750 µm
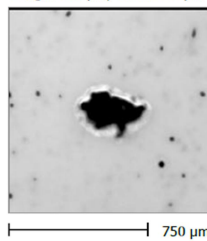
#4 Granule, matt
Length 354 µm, Width 88 µm
750 µm

Width-length diagramm

- Particle event
- Aspect = = 1
- Mean aspect = 2.3
- Aspect = = 10

fibres
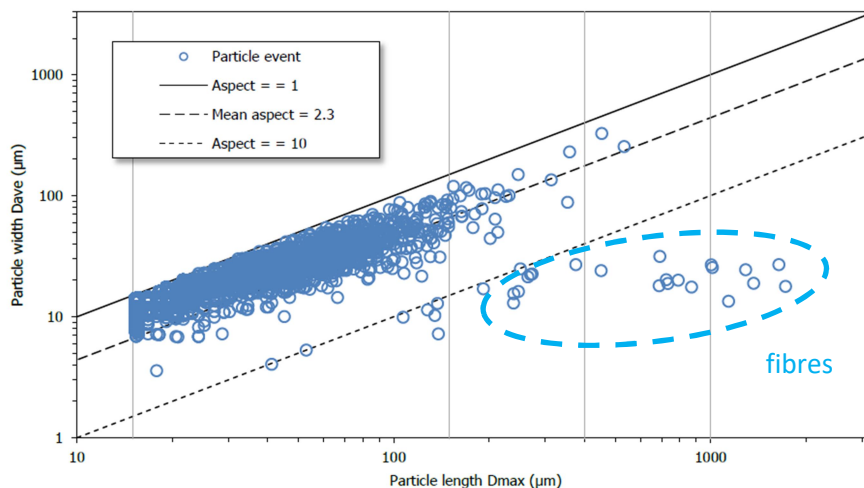
➢ rubber debris with dimension < 0,5 mm
➢ fibers up to 2 mm

☞ what if we do not sandblast the insert?

metal part (not sandblasted); cleaned with plasma

Prüfobjekt / Sample

Bezeichnung / Identification :	Parts A1310800
Prüfvorschrift / Test Directive :	VDA-19:2004-09/ISO-16232:2007-06
Probeneingang / Entry date :	04.06.2014
Transport / Transportation :	per Paketdienst / by parcel service
Verpackung / Packaging :	ordnungsgemäß / proper

Extraktion / Extraction

Verfahren / Technique :	Spritzen mit Drucksprüher, Mitteldruck
	Rinsing with pressure sprayer, medium pressure
Weitere / Further details :	siehe Anhang A / see Appendix A

Tabelle 1 / Table 1
Partikelformen / Particle Shapes

Prüfobjekt / Sample name : Parts A1310800
Partikelanzahl skaliert auf 10 Bauteil(e) / Number of Particles scaled to 10 sample(s)

Erläuterung : Faser = Dmax / Dmin > 10 und Dmin < 25 µm, länglich = 10 > Dmax / Dmin > 2, rund = Dmax / Dmin < 2
Annotation : Fibre = Dmax / Dmin > 10 and Dmin < 25 µm, longish = 10 > Dmax / Dmin > 2, round = Dmax / Dmin < 2

DMAX (µm) Klasse/class	Total Particles	Maximum	[5.0-15.0)	[15.0-25.0)	[25.0-50.0)	[50.0-100.0)	[100.0-150.0)	[150.0-200.0)	[200.0-400.0)	[400.0-600.0)	[600.0-1000.0)	>>>
Fasern/fibres	6836	152.1	5054	1068	462	240	11	1				
Rund/round	28675	221.3	20814	4838	2489	505	24	3	1			
Länglich/longish	63087	254.4	43181	12297	5628	1930	45	5	2			
Particles of interest	98598	254.4	69049	18204	8579	2675	80	9	3			

|	
Statistics	Total, Maximum, >>>
Parameter	DMAX
Method	Reclassified with ZL_rund_lang.zrr
Normalize	Normalized to 1085.439 mm² of search area

Zusammensetzung der längsten Partikel / Composition of Longest Particles

Prüfobjekt / Sample name : Parts A1310800

Erläuterung : Liste der längsten 25 Partikel dargestellt mit Dimensionen Dmax, Dmin, Dperp, Aspektverhältnis, Fläche und Partikelform
Annotation : List of longest 25 particles shown with dimensions Dmax, Dmin, Dperp, Aspect, Area and Particle Shape

DMAX µm	DMIN µm	DPERP µm	ASPECT	AREA um^2	Klasse/class
254.4	23.4	38.5	6.6	3764.6	Coat. Zn
221.3	109.9	119.6	1.9	20785.8	Rund/round
218.6	97.9	106.4	2.1	21547.5	Länglich/longish
194.8	47.3	55.2	3.5	8018.7	Länglich/longish
178.2	121.1	127.4	1.4	16049.6	Rund/round
170.2	28.7	28.9	5.9	4528.1	Länglich/longish
168.1	50.5	62.8	2.7	8072.4	Länglich/longish
166.8	25.3	41.9	4.0	5096.4	Länglich/longish
164.2	77.9	94.0	1.7	9448.1	Rund/round
161.9	56.4	75.8	2.1	6391.5	Länglich/longish
152.1	9.4	9.9	15.3	1146.2	Fasern/fibres
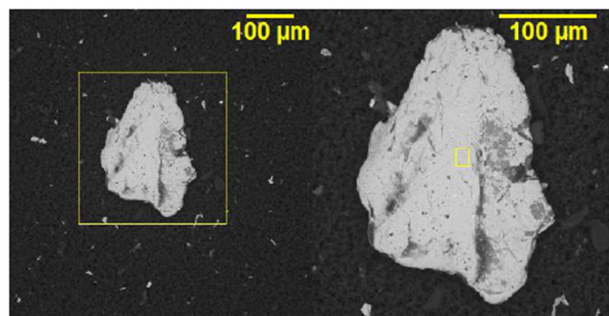
➢ Brass chips and rubber debris with dimension < 0,3 mm

⇨ Best result is obtained with no sandblasting + plasma cleaning

the process of parts

with tight cleanliness spec

have to be

carefully designed